Attachment 4 - Technical Specifications for Weatherization and Home Energy Plus (HE+) Furnace Programs (9/21/12)

This document contains the standards for heating system work performed as part of the Wisconsin Weatherization Program and the HE+ Furnace Program (including the Emergency Furnace program). It is based, in part, on the Wisconsin Weatherization Field Guide, chapters 3 and 7, and applicable requirements from the Wisconsin Weatherization Program Manual.

Table of Contents

Tables

1. INTRODUCTION

The primary emphasis of the following sections is on the repair or replacement of heating systems and general technical specifications. The decision to repair versus replace is based on Emergency Furnace Program policy and is not included in this document. The primary emphasis of the Emergency Furnace Program is to address a "no-heat" or unsafe heat situation. When standards differ between weatherization job heating-system work and Emergency Furnace Program work, in which the primary emphasis is to address a "no-heat" or unsafe heat situation, the difference is identified under "EXCEPTIONS" at the end of each section. All of the Exceptions apply to the Emergency Furnace Program.

References to Chapter 3 refer to the Weatherization Field Guide, which is available at: ftp://doaftp1376.wi.gov/Homeenergy/Field%20Guide%20-%20Revised%20June%202012.pdf . Table references refer to tables in this document (e.g., Table 3-1). The heating system replacement check lists referred to in this document are available at: http://homeenergyplus.wi.gov/category.asp?linkcatid=566&linkid=122&locid=25 (note that the Tune and Clean check lists do not apply to Emergency Furnace work). The most current copy is required.

A. As part of every assessment that results in repair or replacement:

1. All heating systems shall be assessed for safety. Leak-testing gas piping is required.
2. A qualified professional shall complete all mechanical-systems work. Contractors providing services shall be licensed and/or registered to provide those services if required by the authority having jurisdiction.

B. Leak-Testing Gas Piping

Natural-gas and propane piping systems may leak at their joints and valves. Find gas leaks with an electronic combustible-gas detector, often called a gas sniffer. A gas sniffer will find all significant gas leaks if used carefully. Remember that natural gas rises from a leak and propane falls, so position the sensor accordingly.

1. Sniff all valves and joints with the gas sniffer.
2. If the sniffer detects a leak, verify the leak with a non-corrosive bubbling liquid designed for finding gas leaks.
3. All gas leaks verified with bubbling liquid shall be repaired.
4. Replace kinked or corroded flexible gas connectors.

C. Specifications

The specifications in Table 3-1 apply to all replacement heating systems except wood-burning units, and the unit shall meet the following minimum efficiency standards as listed in the AHRI Directory of Certified Product Performance: http://www.ahridirectory.org/ahridirectory/pages/home.aspx.

Table 3-1 Required Annual Fuel-Utilization Efficiency

Replacement heating unit	Required AFUE	ENERGY STAR®
Natural Gas/LP Furnaces	≥ 90% AFUE	No
Oil Furnaces	≥ 83% AFUE	No
Oil-Fired Boilers	≥ 83% AFUE	No
Gas-Fired Boilers	≥ 83% AFUE	No
Manufactured housing – Natural Gas/LP Furnaces	≥ 90% AFUE	No
Manufactured housing – Oil	≥ 79% AFUE	No

- All replacement heating systems for manufactured housing shall be rated for manufactured housing.
- Gas-Fired Furnaces shall conform to ANSI Z21.47–1990 with Addendum Z21.47a–1990 and Z21.47b–1992. Oil Fired Furnaces shall conform to UL4 727, Eighth Edition, 1994 and NFPA 31-2001.

D. Heating-System Sizing Requirements

Install properly sized units following REScheck®, Manual J or equivalent industry-accepted sizing procedures. Heat-load calculations used to size the new heating system shall be based upon anticipated post-weatherization conditions. The Agency shall provide the post-weatherization condition information to the Contractor.

Calculations shall be documented and a copy of the sizing calculations provided to the Agency.

EXCEPTION: When the Agency informs the Contractor, for an Emergency Furnace job, that full weatherization will not occur, the Contractor shall size the new heating system based upon existing conditions.

2. GENERAL HEATING SYSTEM REPLACEMENT

A. General Heating System Replacement — All Types

1. Replace heating systems for health and safety reasons, when the heating unit is totally disabled or is in a life-threatening condition.
2. Photographs shall be provided to the Agency that document furnace conditions existing prior to the provision of services, including manufacturer's nameplate, furnace conditions and any problem(s).
3. New heating appliances shall be installed to manufacturer's specifications, following all local, state and national codes, as required.
4. All heating systems shall be assessed for safety.
5. Leak-testing gas piping is required (follow protocol in above Section 1(B)).
6. Use existing distribution system and supply line.
7. Properly remove and dispose of existing unit.
8. The replacement furnace shall be installed to a dedicated electrical circuit rated or fused to match the amperage of the new system's requirements for overcurrent protection.
9. Install a condensate pump where needed to reach an appropriate drain. Condensate pipes generally may drain to 1) The laundry stand pipe; 2) A new standpipe, indirect or local waste pipe; or 3) A floor with a floor drain, when the pipe can be properly secured and does not pose a hazard to the occupants. All installations require an air break. Condensate lines cannot be drilled directly into any drain pipe. For more information, see Wisconsin Safety and Professional Standards (SPS), 382.33. Local jurisdictions may vary on acceptable options.
10. Condensate pumps may be installed using existing receptacles, new GFCI receptacles, or directly wired per manufacturer's recommendations.
11. Seal openings in chimneys where atmospherically vented appliances are eliminated. Indicate with a written notice on the chimney, where sealed, that the chimney is no longer functional.
12. Replace oil filters.
13. Air filters for forced-air replacement units:
    - If disposable filters are used, provide a total of six (6) 1"– 2" replaceable filters (one of these is installed);
    - or one (1) washable filter (installed);
    - or one (1) deep-pleated filter (installed).
14. All forced-air systems shall have a sealing filter cover. The filter shall be easy to access and replace. Magnetic filter covers are allowable only if they provide an adequate seal to the ductwork to prevent air leakage.
15. Special filters for air cleaning may only be installed as a Health and Safety measure, based on a medical condition.
16. If asbestos abatement is necessary when replacing a heating unit, required protocols shall be followed by appropriately trained and/or certified persons (OSHA and Department of Health Services, DHS 159, http://www.dhs.wisconsin.gov/asbestos/).

17. If the work is performed in a pre-1978 dwelling and more than six square feet of interior paint per room will be disturbed, more than 20 square feet of exterior paint will be disturbed, and any time that windows are replaced or demolished, such work shall comply with DHS Chapter 163 requirements.
18. Provide an owner's manual with heating-system replacements. Attach the manual to or near the heating system for repeated access.
19. All clients shall receive in-home operation, maintenance instructions and a review of safety precautions.
20. For all heating-system work, including replacements, a tag shall be prominently affixed to the heating unit identifying who the customer should call for service. The tag information shall have the name, address and telephone number of the service organization.

EXCEPTIONS: None.

B. Forced-Air Furnace Replacement Standards — General

Observe the following standards in furnace installation and document on the appropriate heating system replacement check list.

1. When necessary, add return ducts or supply ducts as part of furnace replacement to improve air distribution to an acceptable level, to eliminate duct-induced house pressures, and to establish acceptable values for static pressure and temperature rise (supply temperature minus return temperature).
2. Do not add supply registers or return grills to the combustion appliance zone unless it is an intentionally heated part of the home. Consult with customers about the removal of existing grills in the combustion appliance zone.
3. Supply and return ductwork shall be mechanically fastened with screws and sealed to the cabinet with mastic and fabric mesh tape, or other UL 181-approved material, to form an essentially airtight connection on all sides of these important joints.
4. Measure draft, and test for carbon monoxide.
5. High limit shall stop fuel flow at 250° F or less. Furnace shall not cycle on high limit.
6. Fan control shall be adjusted to activate fan at 130° to 140° F and deactivate it at 95° to 105°F, using a thermometer. Slightly higher settings are acceptable if these recommended settings cause a comfort complaint.
7. Static pressure, measured in both the supply and return, shall be within manufacturer's specifications.
8. Seal holes through the jacket of the air handler with mastic or foil tape. Filters shall be held firmly in place and provide complete coverage of blower intake or return register. Filters shall be easy to replace.
9. Set thermostat's heat anticipator to the amperage measured in the control circuit, or follow thermostat manufacturer's instructions for adjusting cycle length. Replace thermostat only if necessary.

EXCEPTIONS: None.

C. Boiler Replacement Standards — General

Replacement boilers shall meet the minimum efficiency shown in Table 3-1, and other applicable requirements shall be followed when replacing boilers. Replacement boilers shall meet the installation requirements shown on the Hot Water Boiler Replacement Check List. A completed copy of the Hot Water Boiler Replacement Check List is required.

Boiler piping and controls present many options for zoning, boiler staging, and energy-saving controls. Dividing homes into zones, with separate thermostats, can significantly improve energy efficiency over operating a single zone. Modern hydronic controls can provide different water temperatures to different zones with varying heating loads.

Follow these specifications when replacing boilers:

1. Size a boiler using REScheck®, Manual J or equivalent calculation. Boiler seasonal efficiency is more sensitive to proper sizing than is furnace efficiency. Also see Section 1(D), "New-Heating-System Sizing Requirements".
2. Inspect radiators. Repair or replace as necessary.
3. Flush the distribution system per manufacturer's instructions or until the water runs clean and is free of sediment.
    a. The system shall have necessary modifications made to work properly with a new boiler.
    b. The system shall *have no leaks.* Repair water leaks in the system.
    c. Stop valves shall be located at accessible points in the supply and return pipe connections and as near to the boiler as is convenient and practical to permit draining the boiler without emptying the system.
4. With a zoned system, each zone shall be flushed separately.
5. Bleed air from radiators and from the entire system.
6. Newly installed zone valves shall be located by the boiler, and each zone shall have shut-off valves.
7. The boiler shall have a pressure-relief valve (PRV) rated and sized correctly for the boiler BTU input and maximum operating pressure and installed according to the manufacturer's specifications.
8. Install an automatic fill valve, if none is present.
9. The feed-water (inlet) side of the pressure-reducing feed valve shall have a backflow preventer, with a shut-off valve installed upstream from the backflow preventer; and the boiler (outlet) side of the pressure-reducing feed valve also shall have a shut-off valve, to allow for maintenance or replacement without draining the boiler system.
10. The backflow preventer shall have:
    a. A drain facing below horizontal.
    b. A pipe from the drain outlet extending to a floor drain or other approved indirect waste receptor, if practical; if not, to 12 inches above the floor.
    c. A pressure-reducing feed valve with either a purge valve or bypass piping with a shut-off valve.
11. The system shall have automatic and manual air-bleed valves to eliminate air from all high points in the distribution-piping system.
12. The system shall have an adequately sized expansion tank. Install an expansion tank, or fill the existing expansion tank and the system to the correct level.
    a. If the existing tank is a pre-pressurized diaphragm type and the tank is older than 10 years, the expansion tank shall be replaced with a properly sized one.
13. Install the pump near the downstream side of the expansion tank to prevent the suction side of the pump from depressurizing the piping, which can pull air into the piping.
14. Extend new piping and radiators to conditioned areas, like additions and finished basements that currently are heated by space heaters, as directed by Agency.

15. Install thermostatically controlled radiator valves on the major radiators; or zone controls; or outdoor reset and boiler controls to adjust supply-water temperature according to outdoor temperature, if feasible for the boiler system.
16. For oil boilers, verify that return-water temperature is above 150° F.
17. For non-condensing gas boilers, verify that return-water temperature is above 130° F, to prevent acidic condensation within the boiler.
    a. Install piping bypasses, mixing valves, primary-secondary piping, or other strategies as necessary to prevent condensation.
18. For condensing boilers, install condensation-resistant venting with condensation drains designed into the venting system per the manufacturer's specifications.
19. Insulate all supply piping outside conditioned spaces. For hot-water systems, install 1-1/2 inch fiberglass insulation on all pipes less than or equal to 1-1/2 inches in diameter, and 2 inches of fiberglass insulation on all pipes greater than 1-1/2 inches in diameter. For steam systems, install 1-1/2 inch fiberglass insulation on all pipes less than or equal to 1-1/2 inches in diameter, and 3 inches of fiberglass insulation on all pipes greater than 1-1/2 inches in diameter.
20. When installed on a floor below grade, a new boiler shall be installed above known flood levels and as high as practical to avoid damage in case of flooding.
21. Inspect chimney for deterioration and correct sizing. If this is a health and safety issue, provide to the Agency a separate cost estimate. Repair and reline the chimney as necessary.
22. Install an electric vent damper where feasible for standard-efficiency boilers.
23. Also see Section 8 of this document, "Hot-Water Space Heating Distribution".

EXCEPTIONS: None.

D. Gas-Fired Heating Installation

Replacement heating systems shall meet the minimum efficiency shown in Table 3-1, and other applicable requirements shall be followed when replacing a gas furnace. Replacement natural-gas and propane furnaces shall meet the installation requirements shown on the Replacement Gas Furnace Check List. A completed copy of the Replacement Gas Furnace Check List is required.

1. Check clearances of heating unit and its vent connector to nearby combustibles, according to the International Fuel Gas Code (IFGC).
2. Verify and make adjustments, if necessary, so that flue-gas oxygen, stack temperature, draft, and carbon-monoxide levels are within ranges specified in Table 3-2 or within manufacturer's specifications.
3. Clock gas meter if necessary to troubleshoot oxygen, temperature, or carbon-monoxide problems. Adjust gas input if necessary to correct the fuel-air mixture.
4. When adjusting gas input, measure gas pressure to ensure that it stays within the range specified in Table 3-2 or manufacturer's specifications.
5. Follow manufacturer's venting instructions along with the International Fuel Gas Code to establish a proper venting system.
6. Follow manufacturer's instructions for proper removal of condensate.
7. Check input gas pressure on furnace when all gas-fired appliances are operating in the house, to assure no drop-off in required gas pressure.
8. Ensure proper sediment trap on gas line.
9. Measure manifold gas pressure and adjust to match manufacturer's specifications.
10. When required, an approved gas-pipe type will be installed, supported, electrically bonded and grounded in accordance with National Fire Protection Association (NFPA) 54 or the Wisconsin Uniform Dwelling Code. Follow the manufacturer's specifications for installation. For more information see NFPA 54 or Wisconsin SPS 323.16. For more information on UDC-approved products go to: http://dsps.wi.gov/sb/SB-CommercialBuildingsXProductE.html.

Gas Combustion Performance Indicator	< 75 AFUE	80+ AFUE	90+ AFUE
Oxygen (% O_2)	5–10%	4–9%	4–9%
Stack temperature (°F)	350°–475°	325°–450°	90°–120°
Carbon monoxide (CO) parts per million (ppm)	<=100 ppm	<=100 ppm	<=100 ppm
Steady-state efficiency (SSE) (%)	68–74%	80–82%	92–97%
Gas pressure (inches water column or IWC)	3.2–4.0 IWC*	3.2–4.0 IWC*	3.2–4.0 IWC*
Propane pressure (inches water column or IWC)	10–11 IWC*	10–11 IWC*	10–11 IWC*
Supply temperature (°F)	120°–140°	120°–140°	95°–140°
* pmi = per manufacturer's instructions			

Table 3-2 – Combustion Standards for Gas-Burning Equipment

EXCEPTIONS: None.

E. Oil-Fired Heating Installation

Replacement heating systems shall meet the minimum efficiency shown in Table 3-1, and other applicable requirements shall be followed when replacing an oil furnace. Replacement oil furnaces shall meet the installation requirements shown on the Oil Replacement Furnace Check List. A completed copy of the Oil Replacement Furnace Check List is required.

1. Properly size the nozzle using REScheck®, Manual J, or an equivalent industry-accepted sizing formula. Also see above Section 1(D), "Heating-System Sizing Requirements"
2. Examine existing chimney and vent connector for suitability as venting for new appliance. The vent connector may need to be re-sized, and the chimney may need to be re-lined.
3. Check clearances of heating unit and its vent connector to nearby combustibles, by referring to NFPA 31.
4. Test oil pressure to verify compliance with manufacturer's specifications.
5. Test control circuit amperage, and adjust thermostat heat anticipator to match.
6. Adjust oxygen, flue-gas temperature, and smoke number to match manufacturer's specifications.
7. Install new fuel filter and purge fuel lines as part of new installation.
8. Visually inspect chimney for safe operation by referring to NFPA 211.
9. Bring tank and oil lines into compliance with NFPA 31.

Table 3-6 – Combustion Standards for Oil-Burning Equipment

Oil Combustion Performance Indicator	Non-Flame Retention	Flame Retention
Oxygen (% O_2)	6–9%	5–9%
Stack temperature (°F)	325°–550°	300°–450°
Carbon monoxide (CO) parts per million (ppm)	<= 100 ppm	<= 100 ppm
Steady-state efficiency (SSE) (%)	>= 75%	>= 80%
Smoke number (1–9)	<= 2	<= 1
Excess air (%)	>= 80%	>= 35%
Oil pressure pounds per square inch (psi)	Š 100 psi	Š 100-150 psi (pmi)*
Over-fire draft (IWC negative)	5 Pa. or .02 IWC	5 Pa. or .02 IWC
Flue draft (IWC negative)	10–15 Pa. or 0.04–0.1IWC*	10–15 Pa. or 0.04–0.1IWC*
* pmi = per manufacturer's specifications		

EXCEPTIONS: None.

3. REPLACING SPACE HEATERS

1. The program does not allow for replacement of portable space heaters.
2. Follow all applicable requirements when replacing space heaters.
3. Follow manufacturer's venting instructions carefully. Don't vent sealed-combustion, induced-draft space heaters into naturally drafting chimneys.
4. Verify that flue-gas oxygen and stack temperature are within the ranges found in Table 3-2.
5. If manufacturer's specifications require a fire-rated floor protector, size it to the width and length of the space heater, as required.
6. Replacement space heaters shall have an air-circulating blower.
7. Space heater shall be provided with a properly grounded duplex receptacle for electrical service.
8. All clients shall receive in-home operation, maintenance instructions and a review of safety precautions.

EXCEPTIONS: The following applies only to an Emergency Furnace job where full weatherization will not occur:

When there are two existing space heaters that are each greater than 15 years old, consider replacing those units with a forced-air heating system. This installation requires prior approval. To obtain prior approval, the Agency shall submit a request to the Home Energy Plus Help Desk. The following information shall be included in the request, and the contractor shall provide this information to the Agency:

1. The estimated or actual steady-state efficiency of the existing space heaters.
2. The cost of replacing both space heaters.
3. The AFUE rating (per AHRI) of the replacement space heaters.
4. The total cost of installing a forced-air heating system.
5. The AFUE rating (per AHRI) of the replacement forced-air heating system.

4. REPLACING WOOD HEATERS

All replacement wood space heaters shall be listed appliances. All wood heaters shall meet applicable local codes and EPA requirements. Mobile-home wood space heaters shall be listed and HUD-approved appliances. All installations shall conform to NFPA 211. All other applicable requirements shall be followed when replacing a wood stove.

Follow these guidelines for replacing wood heaters:

1. All installations shall meet manufacturer's specifications.
2. All wood heating units are certified to meet the EPA emission standards or local standards, whichever are most restrictive.
3. Installed units are certified and labeled by:
    a. NFPA 211; or
    b. International Conference of Building Officials; or
    c. Other equivalent listing organization.
4. Visually inspect chimney for safe operation by referring to NFPA 211.
5. Install a stack thermometer where appropriate on all wood-space-heater installations. Follow the manufacturer's recommendation for proper installation.
6. Follow the manufacturer's recommendations for providing outdoor combustion air.
7. All clients shall receive in-home operation instructions, to include proper wood-burning practices and proper maintenance and safety recommendations, including the need for fire extinguishers.
8. It is important that customers understand the potential impact of exhaust ventilation on wood-heater operation.

EXCEPTIONS: None.

5. VENTING COMBUSTION GASES

Proper venting is essential to the operation, efficiency, safety and durability of combustion heaters. The NFPA and the International Code Council (ICC) are the authoritative information sources on material-choice, sizing, and clearances for chimneys and vent connectors, as well as for combustion air. Applicable codes from the following NFPA and ICC documents shall apply (see Table 3-7):

- The International Fuel Gas Code (IFGC) (ICC)
- NFPA 31: Standard for the Installation of Oil-Burning Equipment
- NFPA 211: Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel-Burning Appliances

Table 3-7 – Guide to Venting Standards

Table 3-7: Guide to Venting Standards

Topic	Code Reference
Vent Sizing	IFGC, Section 504
Clearances	IFGC, Section 308 and Tables 308.2I NFPA 31, Section 4-4.1.1 and Tables 4-4.1.1 and 4-4.1.2 NFPA 211, Sections 6.5, 4.3, 5
Combustion Air	IFGC, Section 304 NFPA 31, Section 1-9; NFPA 211, Section 8.5 and 9.3

A. Improving Inadequate Draft

If measured draft is below minimum draft pressures, investigate the reason for the weak draft. Open a window, exterior door, or interior door to observe whether the addition of combustion air will improve draft. If this added air strengthens draft, the problem usually is depressurization. If opening a window has no effect, inspect the chimney. The chimney could be blocked or excessively leaky. Also see Table 3-11, Draft Problems and Solutions.

i. Duct improvements to solve draft problems

a. Seal all return-duct leaks near furnace.
b. Unless it is a finished living area, there shall be no return-air registers in the combustion appliance zone.
c. Isolate furnace from its return registers by air-sealing.
d. Improve balance between supply and return air by installing new return ducts, transfer grills, or jumper ducts.
e. All remaining natural-draft appliances in the combustion appliance zone shall be properly drafting after the replacement heating system is installed.

ii. Chimney improvements to solve draft problems

a. Remove chimney obstructions.
b. Repair disconnections or leaks at joints and where the vent connector joins a masonry chimney.
c. Measure the size of the vent connector and chimney and compare to vent-sizing information listed in Section 504 of the International Fuel Gas Code. A vent connector or chimney liner that is either too large or too small can result in poor draft.
d. If wind is causing erratic draft, consider installing a wind-dampening chimney cap.
e. If the masonry chimney is deteriorated, consider installing a new chimney liner.
f. Increase the pitch of horizontal sections of vent.

Table 3-11 – Draft Problems and Solutions

Table 3-11:Draft Problems and Solutions

Problem	Possible Solutions
Adequate draft never established	Remove chimney blockage, seal chimney air leaks, or provide additional combustion air as necessary.
Blower activation weakens draft	Seal leaks in the furnace and in nearby return ducts. Isolate the furnace from nearby return registers.
Exhaust fans weaken draft	Provide make-up or combustion air if opening a door or window to outdoors strengthens draft during testing.
Closing interior doors during blower operation weakens draft	Add return ducts, grills between rooms, or jumper ducts.

EXCEPTIONS: None.

6. ELECTRIC FURNACES AND ELECTRIC BASEBOARD HEAT

Note: ***Replacement of an electric heating unit with an electric system is not allowed as part of Emergency Furnace/Heating Unit service.***

If an electric furnace will remain in the building, follow the distribution work requirements, temperature rise, and other applicable requirements.

1. Check and clean thermostat.
2. Clean and lubricate blower if appropriate.
3. Clean or replace all filters.
4. Vacuum and clean blower and housing around electric elements, if dirty.
5. Clean fins on electric-baseboard systems, if applicable.
6. Take extra care in duct sealing and duct airflow improvements for electric furnaces because of the high cost of electricity.
7. Verify that safety limits, temperature rise, and static pressure conform to manufacturer's specifications.

Caution: Disconnect power from electric furnaces before performing any maintenance.

EXCEPTIONS: None.

7. FORCED-AIR DISTRIBUTION WORK — GENERAL

1. Inspect and test ductwork for adequate return, and for health and safety concerns.
2. Seal all major return and supply leaks.
3. The system shall have adequate airflow. Follow the manufacturer's recommendations.
4. Install dampers where supply ductwork is added, and adjust as necessary.
5. Install cold-air returns to all first-floor rooms where feasible, except for kitchen and bathrooms, as directed by the Agency.
6. Install cold-air returns to second-floor rooms as needed, as directed by the Agency.

7. Note: Cold-air return grills are not allowed in the combustion appliance zone and shall not be installed in unconditioned areas or unintentionally conditioned areas.
8. Note: Warm-air registers shall not be installed in the combustion appliance zone, unless the area is an intentionally conditioned area. Consult with customers about the removal of existing grills in the combustion appliance zone.

   When applicable, for additional information regarding "Forced-Air-Furnace Air Distribution", see the Weatherization Field Guide, Chapter 3.

EXCEPTIONS: None.

8. HOT-WATER SPACE-HEATING DISTRIBUTION — GENERAL

Hydronic distribution systems consist of the supply and return piping, the circulator, expansion tank, air separator, air vents, and heat emitters. A properly designed and installed hydronic distribution system can operate for decades without service. However, many systems have installation flaws or need service.

A. Hot-Water Space-Heating Distribution – Safety Checks and Improvements

1. Confirm the existence of a 30-psi-rated pressure-relief valve. Replace a malfunctioning valve or add one if none exists. Note signs of leakage or discharges, and find out why the relief valve is discharging.
2. Make sure that the expansion tank isn't waterlogged or sized too small for the system. This could cause the pressure-relief valve to discharge. Test expansion tank for acceptable air pressure — usually 12 to 22 psi.
3. If rust is observed in venting, verify that return water temperature is above 130° F for gas and above 150° F for oil, to prevent acidic condensation.
4. High-limit control shall deactivate burner at a water temperature of 180° F or less.
5. Lubricate circulator pump(s) if necessary.

B. Hot-Water Space-Heating Distribution – General

1. Remove corrosion, dust, and dirt on the fire side of the heat exchanger.
2. Check for excess air during combustion from air leaks and incorrect fuel-air mixture.
3. Boiler shall not have low-limit control for maintaining a minimum boiler-water temperature, unless the boiler is heating domestic water in addition to space heating.
4. Most systems have an automatic fill valve. If there is a manual fill valve for refilling system with water, it shall be open to push water in and air out, during air purging.
5. Consider installing a two-stage thermostat or timer control to increase circulator on-time compared to burner on-time.
6. Consider installing outdoor reset controllers on larger boilers to regulate water temperature, depending on outdoor temperature.
7. After control improvements like two-stage thermostats or reset controllers, verify that return water temperature is high enough to prevent condensation and corrosion in the chimney as noted previously.
8. Vacuum and clean fins of fin-tube convectors to remove visible dust and dirt there.
9. Insulate all supply piping, passing through unheated areas, with foam pipe insulation, at least one-inch thick, rated for temperatures up to 200° F.
10. Consider installing electric vent dampers on atmospheric gas- and oil-fired high-mass boilers.

EXCEPTIONS: None.

9. HEATING-UNIT REPLACEMENT IN MANUFACTURED HOUSING

Replacement gas furnaces shall be sealed-combustion, downflow, condensing furnaces, approved for use in mobile homes. Replacement oil furnaces shall have a minimum AFUE rating of 79% and be approved for use in a mobile home. All other applicable requirements shall be followed when replacing a furnace.

Follow these procedures when installing new mobile-home furnaces:

1. Install properly sized units according to REScheck®, Manual J or an equivalent industry-accepted sizing formula.
2. Size the heating unit so that the existing compartment can accommodate it without major retrofitting, and ensure that the fit and finish is appropriate for the compartment. An installation that requires retrofitting requires prior approval from the Agency.
3. Order and install a new furnace base, unless you are sure that the existing base matches the new furnace.
4. Support the main duct underneath the furnace with additional strapping if necessary to hold it firmly in place.
5. Attach the furnace base firmly to the duct connector. Seal all seams between the base, the duct connector, and main duct with mastic and fabric tape.
6. Before installing the furnace, carefully seal the base plate to the floor in order to prevent air leakage through the belly and floor.
7. Convert a belly-return system to a living-space-return system by rerouting returns to furnace cabinet door.
8. Ensure that there is adequate return air.
9. Provide a complete air seal and weather seal around the new chimney and combustion-air pipe where it penetrates the roof, ceiling, wall, or floor.
10. Provide a complete water-tight weather seal at the roof penetration. Reinforce the area underneath the roofing with plywood or other strong material if necessary to create a strong patch and to prevent a low spot in the roof at the penetration. It is best for any roof patch to be slightly elevated from the surrounding roof, to prevent water collection at the patch.
11. Conduct a combustion test and compare test results to the specifications in Table 3-2 Take action to correct non-conforming specifications.
12. Install a condensate pump if necessary to convey the furnace's condensate to a suitable drain. Install condensate lines in a manner that guards against freezing.
13. Use existing distribution system and gas-supply line.
14. Properly remove and dispose of existing unit.
15. Provide an owner's manual with heating-system replacements.
16. All clients shall receive in-home operation, maintenance instructions and a review of safety precautions.

EXCEPTION: When full weatherization work will not be performed, disregard Item 7) above.

10. PROGRAMMABLE THERMOSTATS

Refer to the Wx Program Manual, Appendix B.4.2(7) and (8); and to the Wx Field Guide, Chapter 3.15, "Programmable Thermostats", for specifications and guidance regarding programmable thermostats.

EXCEPTIONS: When full weatherization work will not be performed, a new thermostat shall not be installed unless the existing thermostat is not working properly and requires replacement. When a new thermostat is required, follow the indicated sections of the Wx Program Manual and the Wx Field Guide.

11. DUCT INSULATION AND DUCT SEALING

Refer to the Wx Field Guide, Chapter 3.13, "Forced-Air Furnace Distribution", for specifications and guidance regarding duct insulation and duct sealing.

EXCEPTION: When full weatherization work will not be performed, there is no requirement to insulate ducts. For duct-sealing requirements, see Section 7(2), "Forced-Air Distribution Work – General", of this document.

12. CLEANING & TUNING GAS AND OIL FURNACES

Refer to the Wx Field Guide, Chapter 3.9, "Testing and Servicing Combustion Systems", for specifications and guidance regarding the cleaning and tuning of gas combustion appliances. Refer to the Wx Field Guide, Chapter 3.10, "Oil-Burner Safety and Efficiency", for specifications and guidance regarding the cleaning and tuning of oil furnaces.

EXCEPTION: When full Weatherization will not be completed, a full clean and tune is not required, only perform those services necessary to have the system running properly.

13. WORST-CASE DRAFT PROTOCOL

Refer to the Wx Field Guide, Chapter 3.11.1, "Worst-Case Draft Protocol".

EXCEPTION: Test remaining natural-draft appliances for draft under natural conditions, not under worst-case (depressurization) conditions.

14. COMBUSTION AIR

Refer to the Wx Field Guide, Chapter 3.12, "Combustion Air", for specifications and guidance regarding combustion air. The Agency shall determine whether the combustion-appliance zone requires additional combustion air.

EXCEPTION: When full weatherization will not be performed, the contractor shall determine whether the combustion-appliance zone has sufficient combustion air. Only add combustion air with Agency approval.